Benefits of AVL

A number of trucking industry executives and managers were interviewed in order to obtain their views on the benefits of Automatic Vehicle Location (AVL) systems for local trucking fleets. Their comments are reviewed below:

1. Driver Productivity

Glenn Taylor, P&D Supervisor for Hyman Freightways in Chicago, reports that in 1992 Hyman installed the Air Touch (formerly PacTel) Teletrac AVL system on 50 trucks used in their local P&D operation. This system uses a network of land-based transmitting and receiving antennas to compute the location of fleet vehicles and for optional data messaging. Taylor referred to the tracking system as "an overtime saver". He stated that Hyman has experienced a reduction of about $2,000 per month in overtime expenses since installing the system. He estimates the overall increase in productivity resulting from use of the tracking system at 5-10%. Taylor is confident that his company has already recouped their investment in the AVL system through increased productivity.

Wrag-time Transportation in Huntington Park, California, has used a tracking system on its 20 LTL trucks since 1991. Michael Smith, General Manager of Wrag-time, reports that while his primary motive for installing the tracking system was security, the company has realized a substantial increase in driver productivity since they began using the system. Smith says that the tracking system and a newly initiated driver incentive program have been the main contributors to a 25% increase in driver productivity.

J.B. Hunt is currently using the Teletrac AVL system on 140 trucks in its Los Angeles P&D operation. Doug Rockwell, who is responsible for Hunt's P&D operations nationwide, says that productivity, dispatching efficiency and security were factors in the decision to use AVL in the Los Angeles operation. Rockwell indicates that, typically, a small minority of drivers produce below a minimum acceptable level, costing the company capacity. AVL is a useful tool for dealing with this problem. Rockwell reports that Hunt plans to install both AVL and two-way radios on the balance of its nationwide 600 unit P&D fleet by mid-1995. The company will select the best available AVL system to meet its needs in each geographic area. Doug Rockwell expects to obtain a 5% increase in productivity from AVL and another 5% from the two-way radios.

Carolina Freight Carriers recently installed an AVL system on the 30 trucks in the company's Chicago-based LTL fleet. Braxton Vick, Executive Vice President of Carolina Freight Carriers, reported that he believes the system will increase driver productivity and reduce overtime. Vick selected the Teletrac AVL system based on cost and the system's data messaging capability which he feels eliminates the need for two-way radios. Carolina Freight Carriers plans to expand the use of Teletrac to Carolina's LTL operations in other cities with Teletrac networks. Braxton Vick has looked at GPS-based AVL systems, but feels that to date they are too expensive.

2. Dispatching Efficiency and Customer Service

Stewart Cartage, a small LTL operator in Detroit, uses a vehicle tracking system on 11 LTL trucks which provide just-in-time delivery for the automotive industry. Jeff Stewart, President of Stewart Cartage, reports that in his business "75% of the benefit of AVL is in providing better customer service". Customers call and ask "where's the truck?" They are invariably impressed when his dispatcher tells them its exact location within seconds. The AVL system has helped Stewart Cartage attract new business from customers who need fast response. It also helps dispatchers to quickly locate addresses and guide drivers to unfamiliar pick-up points. According to Jeff Stewart, driver response to the AVL system has been "100% positive" since they regard the system as a tool that makes the company's operation more efficient and their jobs easier.

Remlo Transporation in Chicago, a subsidiary of DSC Logistics, has a tracking system installed on 38 trucks servicing the Greater Chicago area. Todd Goranson, who manages the dispatch operation for Remlo, reports that in addition to improving driver productivity, the AVL

Continued on page 4

Cargo CATS

The Los Angeles Cargo Criminal Apprehension Team (Cargo Cats) is multi-agency unit including officers from the L.A. County Sheriff's Office, the California Highway Patrol, the FBI, the Vernon Police Department, the Los Angeles Port Police and the Los Angeles Police Department. Sergeant Steve Lawson of the Cargo Cats reports that cargo and truck/trailer losses in the Los Angeles area are estimated at $1 million a day. In 1993, 540 grand thefts and 135 hijackings were reported. Reported stolen freight losses totaled $109 million. Sgt. Lawson indicates that the actual numbers are substantially higher than the reported numbers.

Sgt. Lawson states that companies using a tracking system have seen a dramatic decline in losses due to the ability to locate the truck or trailer after it is stolen. He stated that the Cargo Cats have been involved in recovering a number of these stolen vehicles. Lawson indicated that most companies using tracking systems in Los Angeles today are using the Teletrac system. While the system's coverage area is somewhat limited, Lawson says Teletrac has an excellent recovery record.

Continued from page 3

system is a "great dispatching tool". By identifying the closest vehicle to a call, the system reduces customer response time. Remlo often demonstrates the system to potential customers and has found the system to be an effective marketing tool. Goranson is confident that in the 9 months Remlo has been using the tracking system they have already recouped their investment.

Glenn Taylor of Hyman Freightways and Michael Smith of Wrag-time Transportation report that, in addition to improving driver productivity, their AVL systems are also valuable dispatching tools. **Doug Rockwell of J.B. Hunt states that identifying the closest available vehicle with AVL is helpful, but getting drivers to report that they are "soon to be available", one hour in advance, would bring about a significant improvement in fleet efficiency.** He points out that this is a matter of establishing procedures and not something to be solved by AVL technology alone.

3. Security

A large number of local trucking companies, particularly those operating in the Los Angeles area, have installed AVL primarily for security. Most AVL systems are available with "panic buttons" which enable the driver to transmit an emergency message, along with the truck's location, when faced with a threatening situation. AVL systems also allow stolen trucks to be located quickly, which often makes it possible to recover valuable cargo before it can be removed.

Doug Rockwell reports that J.B. Hunt's primary motives for installing a tracking system on its Los Angeles P&D fleet were the desire to maximize driver productivity and dispatching efficiency. However, after installing the system, the company recognized the increased security the system could provide for drivers and cargo. Consequently, panic buttons have been installed in each cab. Rockwell states that while a panic button will not avert a hijacking, it gives drivers a greater sense of security knowing they can call for help when faced with a potentially dangerous situation.

Gary Critelli, Director of Operations Research for Con-Way Transportation, reports that Con-Way installed tracking units with panic buttons in 150 trucks involved in shuttling containers to and from the Port of Long Beach. **The AVL system was installed due to the alarming number of truck thefts and hijackings** in the Los Angeles area. Con-Way uses the Air Touch Teletrac system and requires other carriers, to whom loads are subcontracted, to use the system as well. To date, Con-Way has had one stolen truck recovered through use of the tracking system.

Matthew Mlynarczyk, Executive Director of the American Trucking Association's National Freight Claims and Security Council, reports that more trucking companies are now using AVL systems for security. **This is a response not only to cargo losses, but to violent crimes targeted at truck drivers.** Mlynarczyk states that with a tracking system, a driver summon help with a panic button or just step away from the rig and make a phone call. The chances of the incident resulting in injury to the driver or loss of the cargo are reduced. Mlynarczyk reported that the Teletrac system, which is most widely used, has an excellent recovery rate.

Other Productivity Tools

Pat Lemmon, Director of Operational Services for Yellow Freight, reports that his company is considering a number of systems for improving fleet management. Yellow Freight is looking into systems for transmitting bills of lading information from the field and more efficiently transmitting pick-up assignments to drivers. Management is looking into better ways to balance driver workloads by getting better workload data to dispatchers. They are interested in systems to approximate driver locations, based on the time and location of the last stop. They believe that a portable 800 MHz data terminal, which can receive downloads from dispatch and allows for data transmissions from the driver, will address some of these issues. Lemmon reports that Yellow Freight may consider adding AVL to the mobile communications systems under evaluation and may favor satellite-based systems, which offer the broadest coverage.

Mr. Rockwell reports that J.B. Hunt plans to install both AVL and two-way radios on the balance of its nationwide 600 unit P&D fleet by mid-1995. Doug Rockwell expects to obtain a 5% increase in productivity from AVL

In addition to using AVL on its Chicago LTL fleet, Carolina Freight Carriers has also installed Racotek mobile data terminals on 29 trucks operating from the company's P&D terminal in Charlotte, North Carolina. The mobile data system is tied into **the terminal's central computer system which also computes optimal routes for each driver.** According to Braxton Vick of Carolina Freight, status updates from the drivers generally make it possible to identify the closest vehicle to a pick-up point.

Southeastern Freight Lines, which operates an LTL fleet of 1,200 trucks, has equipped its fleet with American Mobile Satellite Corporation (AMSC) satellite communication terminals. John Rader, VP of Marketing, reports that

the terminals were installed to enable drivers to transmit "skeleton bill" information to dispatch. This includes the number of cartons, total weight and destination. By receiving this information at the linehaul terminal long before the truck arrives, supervisors can calculate how many trucks are needed to carry the freight to destination terminals as well as the number of workers needed to consolidate and load the freight. Rader indicates that the AMSC system enables Southeastern Freight Lines to keep customers better informed of shipment status. The system's GPS-derived vehicle location information is primarily used to estimate time of arrival and for locating trucks that are late in arriving.

Emery Air Freight, part of the Consolidated Freightways organization, is one of the package delivery companies which is competing with LTL carriers for small loads. Paul Klepacz, Director of Information Technology for Emery, reports that the company is currently using the AirTouch Teletrac system on approximately 100 delivery trucks operating in the Los Angeles and Ontario, California area. This system was installed to increase security, as well as improving productivity and efficiency. Klepacz reports that Emery is attempting to increase the efficiency of fleet operations nationwide by integrating computer-aided dispatch, AVL and mobile data. Driver assignments will be downloaded into handheld mobile data terminals throughout the course of the day. According to Klepacz, this will be much more efficient than the current system of putting routing instructions on cards and passing verbal instructions to the driver over the two-way radio.

Wes Kemp, VP of Terminal Operations for ABF Freight Systems, is also looking for effective ways to improve fleet efficiency. Kemp is looking for a rugged fax machine which would enable drivers to fax bills of lading from the field. Drivers could also receive a fax with their next pick up assignment. Kemp will consider GPS-based AVL systems when prices drop to $500 per vehicle. ■

Tracking Systems for Metro Trucking Fleets

The mobile communication systems used by linehaul carriers are not widely used by local fleet operators due to cost. However, some suppliers of these systems have their eye on the local market and are evaluating the price points and system features needed to address this market.

While most systems servicing longhaul fleets use satellites for communication, local fleets have access to less costly means of communicating, such as two-way radios. Vehicle tracking systems for metropolitan area fleets generally use either a two-way radio network to transmit satellite-derived location data or use a separate land-based

Continued on page 6

	QUALCOMM INC.	AIRTOUCH TELETRAC	AMER MOBILE SATELLITE CORP. (AMSC)	ROCKWELL INTERNATIONAL	HIGHWAY MASTER
Service	OmniTRACS	Fleet Director	SkyCell	ProSeries	HighwayMaster
Primary Markets Served	Longhaul	Local Trucking & other metro area fleets	Longhaul	Longhaul	Longhaul
Coverage	U.S., Europe, Brazil, Japan, Mexico, parts of Canada	Los Angeles, Chicago, Detroit, Miami, Dallas/Fort Worth, Houston	U.S.	U.S.	U.S. and Canada
Location Technology	Qualcomm Automatic Satellite Position Reporting System	Land-based Radio Location Network	GPS	GPS	•Enhanced Loran-C •GPS optional
Location Accuracy	1,000 feet	150 feet	100 meters	100 meters	•Enhanced Loran-C: 1,300 feet •GPS: 100 meters
Communication Network	Communication Satellites	Proprietary Land-based Network	•Current - Inmarsat Satellite •1995 - AMSC Communication Satellites	•Current - Inmarsat Satellite •1995 - AMSC Communication Satellites	Cellular
Communication Services	Two-way Data and Location	Two-way Data Messaging and Location	•Two-way Data and Location •1995: Voice available	•Two-way Data and Location •1995: Voice available	Two-way Data, Location, and Voice
Hardware Costs	$3,600 - $4,500 per vehicle	•Transceiver: $450 per vehicle •Optional Message Terminals: $200 - $400	$3,500 - $4,450 per vehicle	Competitive with other satellite-based systems	$2,000 per vehicle
Service Costs	Average $50 - $60/mo. per vehicle	•$20/mo. per veh. (Location only) •$35/mo. (Location and Data)	Average $50 - $60/mo. per vehicle	Average $50 - $75/mo. per vehicle	Average $100 - $120/mo. per vehicle
Installed Base	•300+ Fleets •75,000 vehicles	•1,000 Total (100 Trucking) Fleets •29,000 vehicles	Company Proprietary	•4,000 Units Sold •2,000 Units Installed	3,000 Units

Continued from page 5

network for both location and communication.

Two types of vehicle location systems are available for local trucking operators. The first type, AVM-band systems (AVM stands for Automatic Vehicle Monitoring) are only available at this time in a few major cities. Systems which use the GPS satellites for location are available virtually anywhere, but due to cost these systems have yet to penetrate the local trucking market.

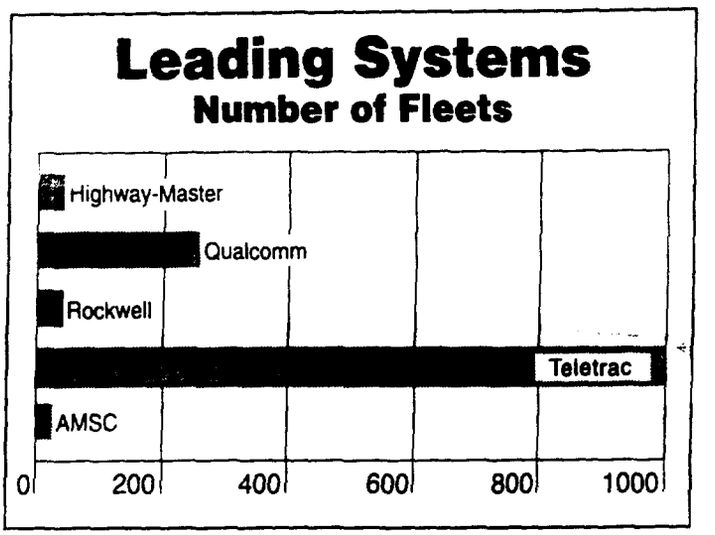
Available Mobile Communication/ AVL Systems for Trucking

- **Qualcomm**, with its OmniTRACS system, is the largest supplier of mobile communications systems for linehaul fleets. OmniTRACS is installed on over 50,000 trucks operated by some 250 U.S. fleets. The OmniTRACS system provides data communications between drivers and dispatch, using leased capacity on geostationary satellites for communications. The location of fleet vehicles is computed at the OmniTRACS network hub to within a quarter mile using time delay measurements of signal transmissions between the satellites and vehicle. OmniTRACS terminals typically sell for $3,500 - $4,000 and monthly usage averages $70 per vehicle.

- **AirTouch Teletrac** is the largest supplier of AVL for local trucking and other metropolitan area fleets. The Teletrac system is installed on some 29,000 vehicles operated by over 1,000 fleets. The Teletrac system is based on a network of transmitting and receiving antennas installed around a metropolitan area. Teletrac networks are currently operational in Los Angeles, Chicago, Detroit, Miami, Dallas and Houston. Teletrac transceivers are priced at approximately $400 and optional data terminals are available for $200-$400. Monthly usage is priced at $20 per vehicle for location only and $35 for location and data messaging.

- **American Mobile Satellite Corporation** (AMSC), based in Dulles, Virginia, also offers a mobile communication system for longhaul trucking and other applications. AMSC currently provides mobile data communications for TMC Transportation, Inc., Southeastern Freight Lines and other carriers by using the Standard-C data service

Continued on page 7



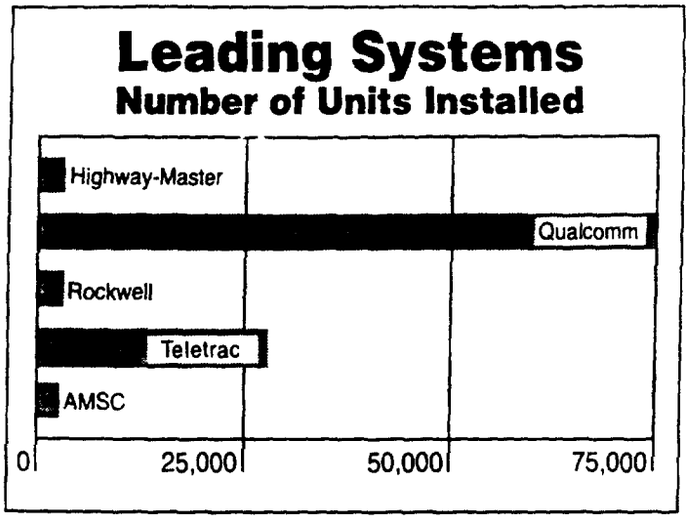
1. AVM-Band Systems

The vehicle tracking system most widely used by metropolitan area fleets today is the Air Touch Teletrac Fleet Director system. The Teletrac system operates in what is known as the AVM (Automatic Vehicle Monitoring) band. The AVM band, 902-928 MHz, is shared by licensed subscription-based vehicle location system operators and several other user categories.

The Fleet Director system is based on a network of transmitting and receiving antennas installed around a metropolitan area. To locate a fleet vehicle, the dispatcher requests the location through the Teletrac workstation. A paging signal is transmitted through the Teletrac network to the transceiver installed in the vehicle. The transceiver responds by transmitting a short spread-spectrum code burst which is received by Teletrac antennas. The Teletrac Control Center uses time of arrival measurements on the received signals from four or more antennas to compute the vehicle's location with an accuracy of about 100 feet. The location of fleet vehicles is shown on the Teletrac workstation's digital map display.

The Air Touch Teletrac system has been installed on over 28,000 vehicles operated by some 950 fleets, including over 90 LTL, P&D and intermodal carriers. The Teletrac system is currently operational in Los Angeles, Chicago, Detroit, Miami, Dallas and Houston. Teletrac transceivers are priced around $400 and the monthly subscription charge averages $20 per vehicle. For an additional monthly charge of $15 per vehicle Teletrac offers optional status messaging from the vehicle to dispatch and full text messaging from dispatch to the vehicle. Teletrac workstation software, to operate on a customer-supplied PC, is available for $2,500.

Several other companies including Southwestern Bell, Pinpoint Communications and MobileVision plan to introduce AVM-band systems in the near future. Pinpoint Communications' system is designed to provide AVL and low cost mobile data transmission (estimated at under $.01 per packet). The company plans to conduct a six month commercial test program in Dallas in the first half of 1995 and will deploy its system in other major cities, contingent upon funding. MobileVision's system supports both voice and data transmission, as well as AVL. MobileVision hopes to begin deployment of its system during the second half of 1994 in cities such as Chicago, Washington, D.C. and Dallas. MobileVision, like Pinpoint and other AVM-band system operators, will require substantial funding in order to proceed with widespread commercial deployment.



2. GPS-Based Systems

The Global Positioning System (GPS) is a satellite navigation system which was deployed by the U.S. government, primarily for military applications. However, GPS has more civil and commercial applications today than military. One of these is vehicle location.

The GPS constellation consists of 24 satellites positioned in six orbital planes at an altitude of 10,900 nautical miles above the earth. The satellites continuously transmit signals which enable GPS receivers to accurately measure the time delay of the transmissions. Since the signals travel at the speed of light, the time delay is easily converted by the receiver to distance or range to the satellite. Range measurements to a minimum of four satellites (three if the vehicle's altitude relative to sea level is fairly constant) are required to compute position. GPS position accuracy is typically about 50 meters, which is less than half a city block.

Unlike AVM-band systems, which compute position at a central control center, GPS receivers compute location at the vehicle. A communication link, usually two-way radio, is required to transmit the location of the vehicle to the fleet's dispatch base station. Special modems and software make it possible to transmit location and other data over Specialized Mobile Radio (SMR) networks, in addition to dedicated two-way radio channels.

GPS-based AVL system in-vehicle equipment generally consist of a GPS receiver and antenna and a modem/processor, interfaced to the two-way radio. Optional mobile data terminals and in-vehicle sensors may also be included. A base station with a computer map display and software is installed at the dispatch center. There are many suppliers of GPS-based AVL systems including Rockwell International Corporation in Anaheim, California, Navigation Data Systems (NDS) in New Orleans, Louisiana, and AUTO-TRAC in Dallas, Texas. Prices are generally $1,500 - $2,000 per vehicle for a basic system and $20,000 or more for the base station and software.

The relatively high price of GPS-based AVL systems has limited its penetration of local trucking fleets. While many ambulance companies and some police departments, utility and transit fleets use GPS-based AVL to improve response times and overall fleet efficiency, few, if any, local trucking operators are using these systems today. However, prices of GPS-based AVL systems are coming down and it appears that a number of local trucking operators will install these systems in the next 12 months. Interest in these systems is based on the unlimited coverage area available from GPS (though system coverage may be limited by the coverage area of the fleet's two-way communication system). GPS signals are also available to all users free of charge. The only recurring cost of GPS-based systems is the incremental cost of transmitting location data over a subscription-based communication link, such as an SMR network. ■

Continued from page 6

available through the INMARSAT satellite network. GPS is used to compute the location of fleet vehicles. AMSC plans to launch its own communication satellite in March, 1995, which will enable the network to support voice communications in addition to data. AMSC in-vehicle terminals are currently price competitive with OmniTRACS, but user set prices will reportedly be reduced to under $2,000 following launch of the AMSC satellite. AMSC reports that the typical monthly usage charge per vehicle is $50 - $70.

- **Rockwell International's Highway Transport Electronics Group** in Cedar Rapids, Iowa, offers the ProSeries Mobile Communications System which, like AMSC, currently provides data communications using INMARSAT Standard-C service. Rockwell offers its own in-vehicle hardware and fleet management software and will become a reseller of AMSC network services when the AMSC satellite becomes operational in 1995. Rockwell customers include J.B. Hunt (which also uses OmniTRACS) and CRST, Inc. Rockwell's prices are competitive with OmniTRACS and AMSC.

- **HighwayMaster** of Dallas, Texas, has developed a mobile communication system for the trucking industry which uses the cellular network to provide both voice and data communications. HighwayMaster worked with major cellular operators in establishing what the company refers to as an enhanced seamless cellular network. The HighwayMaster system computes the general location of the vehicle by identifying the closest cell site. For higher accuracy, Loran-C or GPS are used for vehicle location. HighwayMaster customers receive a monthly bill, which averages $100 - $120 per vehicle, covering airtime, long distance and administrative charges. The price per vehicle for the HighwayMaster system is under $2,000.

A Look at the Future

It is clear that vehicle tracking is one of the principal fleet management tools which will be increasingly used by local fleet operators in coming years. Fleet operators using this technology today are experiencing benefits such as increased driver productivity, increased dispatching efficiency, enhanced customer service and improved security for drivers and cargo.

The principal factors which have delayed widespread use of AVL by local trucking companies are availability of affordable AVL systems and lack of awareness of system benefits. Awareness of AVL is growing as major operators begin to adopt this technology.

Where available, low cost AVM-band systems (specifically Teletrac) have gained good acceptance in the local trucking market. Affordable AVL systems will become much more widely available over the next few years. Several factors will bring this about:

- The price of GPS-based AVL systems will come down significantly from the current level of $1,500 - $2,000 per vehicle.
- New mobile communication networks will be deployed which will support low cost data transmission. A consortium of major cellular operators are currently implementing Cellular Digital Packet Data (CDPD) capability in their networks which will support transmission of data packets, such as location information, at a cost of $.05 or less per packet. Enhanced Specialized Radio Networks (ESMR), digital versions of the current analog subscription-based two-way radio networks, are currently being deployed. These systems will help to make the transmission of vehicle location and other data economical and reliable.
- Low cost AVM-band systems, such as Air Touch Teletrac, should become available in a greater number of metropolitan areas. Technology improvements are expected to result in lower hardware prices for Teletrac and other soon-to-be-deployed AVM-band systems.
- Two-way paging networks, such as the Nationwide Wireless Network (NWN) to be implemented by Mobile Telecommunication Technologies Corporation (Mtel) should provide an effective communication link for AVL and other mobile data applications. Deployment of NWN in major metropolitan areas is scheduled for 1995.
- Low earth-orbit satellite systems, such as the ORBCOMM system to be deployed by Orbital Communications Corporation, will begin to offer low cost mobile communications for longhaul trucking companies by 1996. User equipment costs are projected at $400 per unit. Usage rates will be high for frequent users, but may be affordable for some local trucking fleet applications. ■

Over the next few years, vehicle tracking systems will become nearly as common in local fleet operations as two-way communications.

Conclusion

Local trucking companies, faced with increasing competition, are seeking ways to increase operational efficiency. A growing number of operators are installing vehicle tracking systems which have been found to increase driver productivity, enhance dispatching efficiency, strengthen customer loyalty through improved service and attract new business. Trucking companies in port areas such as Los Angeles are using AVL systems to increase security for both drivers and cargo.

Most metropolitan area trucking operators using AVL today are using the AirTouch Teletrac system. A number of major carriers are considering the use of GPS-based AVL systems, and acceptance of this technology will grow as system prices decline. Over the next few years, vehicle tracking systems will become nearly as common in local fleet operations as two-way communications. AVL will be one of the principal tools fleet managers will use to maximize the efficiency and security of their operations and to strengthen their position in a highly competitive industry. ■

Author's Bio

Clement Driscoll is principal of C.J. Driscoll & Associates of Rancho Palos Verdes, California, which provides consulting services on automatic vehicle location (AVL) and mobile communications to fleets and industry suppliers. Mr. Driscoll has held senior marketing positions with major suppliers of mobile communications and radiolocation products and systems. He has written articles on AVL and mobile communications for *Automotive Fleet*, *GPS World* and *Communications* magazines.

Copyright © 1994 by C.J. Driscoll & Associates. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopy, recording, or otherwise without the prior written consent of the author.

CERTIFICATE OF SERVICE

I, Tracie R. Ivey, a secretary at the law firm of Dow, Lohnes & Albertson, do hereby certify that on this 5th day of November, 1997, I caused copies of the foregoing "Comments of Teletrac, Inc." to be served via hand delivery to the following:

Commissioner William E. Kennard
Federal Communications Commission
1919 M Street, N.W., Room 814
Washington, DC 20554

Commissioner Susan Ness
Federal Communications Commission
1919 M Street, N.W., Room 832
Washington, DC 20554

Rosalind K. Allen
Deputy Bureau Chief
Wireless Telecommunications Bureau
Federal Communications Commission
2025 M Street
Washington, DC 20554

Commissioner Harold Furchtgott-Roth
Federal Communications Commission
1919 M Street, N.W.
Washington, DC 20554

Karen Gulick
Assistant Chief
Wireless Telecommunications Bureau
Federal Communications Commission
2025 M Street, Room
Washington, DC 20554

Commissioner Michael Powell
Federal Communications Commission
1919 M Street, N.W.,
Washington, DC 20554

Kathleen O'Brien Ham
Chief-Auctions Division
Wireless Telecommunications Bureau
Federal Communications Commission
2025 M Street, Room
Washington, DC 20554

Commissioner Gloria Tristani
Federal Communications Commission
1919 M Street, N.W.,
Washington, DC 20554

Gerald P. Vaughan
Deputy Bureau Chief
Wireless Telecommunications Bureau
Federal Communications Commission
2025 M Street, Room 5002
Washington, DC 20554

David Furth
Chief - Commercial Wireless
Wireless Telecommunications Bureau
Federal Communications Commission
2025 M Street, Room

Tracie R. Ivey
Tracie R. Ivey